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Random drug and alcohol testing for preventing injury in workers (Protocol)

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[Intervention Protocol]

Random drug and alcohol testing for preventing injury in workers

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ABSTRACT

This is a protocol for a Cochrane Review (Intervention). The objectives are as follows:

To assess the effectiveness of workplace RDAT to prevent injuries and improve noninjury outcomes in workers compared with no workplace RDAT.

BACKGROUND

Humans have been consuming psychoactive substances since prehistoric times (Guerra-Doce 2015). In current society, substance use represents a leading cause of preventable death and disease, as well as a significant global public health concern and economic burden. Before the advent of the industrial revolution, the consumption of alcohol in some workplaces was normalized, and alcohol was often viewed as a substitute for water - at times even offered to workers as payment (Trice 1981). A normative shift occurred in the early 20th century, with increasing denormalization of alcohol consumption in the workplace (Taylor 1915). At the beginning of the 21st century, attention to the use of drugs other than alcohol led to concern about the potential adverse impact of these drugs on safety in the workplace (Frone 2013).

Description of the condition

Numerous factors, both occupational and nonoccupational, contribute to workplace injuries (Dong 2015). The consumption of psychoactive substances, among other factors, may result in occupational impairment and, hence, occupational injury risk. Abuse of alcohol, cocaine, marijuana, and other substances is associated with workplace injuries (Chau 2009; Dong 2015; Pollack 1998; Shipp 2005). Substance abuse has become a growing concern for employers with regards to meeting their obligation to maintain a safe and healthy workplace, as approximately 5% to 18% of adults (age range 18 to 64 years) employed in a full-time capacity fulfill the criteria for a substance use disorder (Bush 2015). It is well established that alcohol and drug use impairs skills related to operating a vehicle or machine. The cognitive, motor, and other skills required for safety-sensitive and decision-critical duties overlap to varying degrees with those required to operate a motor vehicle or machinery in a safe fashion; driving can be viewed as a proxy for the prediction of impairment for other safety-sensitive (Hegmann 2014) and by extension, decision-critical tasks. Both alcohol and

other drug use contribute to the risk of an accident, and the risk of being fatally injured is increased when drivers, whether or not they have consumed alcohol, test positive for another drug (Romano 2014). Sources of data that address work-related injuries and accidents come primarily from medical examiner records and workplace drug testing programs (Frone 2013). Estimates suggest that alcohol-related impairment occurs in approximately 5% and 10% of nonfatal and fatal work injuries, respectively (Zwerling 1993). The positive post-accident drug testing rates for over 37.5 million workers screened over a period of five years in the USA were 2.6% in federally mandated safety-sensitive occupations, and 5.6% in the general workforce (Zwerling 1993).

With the increased focus on the impact of alcohol and drug use both in and outside the workplace, greater attention is being given to interventions to mitigate the risk of harm, especially in safety-sensitive work settings. Currently, marijuana represents the most commonly used illicit substance overall, and the most commonly found substance in a workplace drug testing context (Els 2016). Approximately 20% of workers are employed in safety-sensitive positions, and the USA 2015 National Survey on Drug Use and Health found that approximately 70% of adults in the USA who reported using illicit substances in the past month are employed (SAMHSA 2016). In North America, with the ongoing progressive legalization of marijuana and the existing opioid use epidemic, we consider the corresponding potential for a serious adverse impact on occupational health and safety to be likely, substantial, and foreseeable. It is estimated that in the Alberta workforce in 2002 there was an impact value of over $32 million Canadian dollars (CAD) due to lost productivity related to alcohol use; whereas the impact related to drug use was over $13 million CAD (AADAC 2003).

On 24 March 1989, the Exxon Valdez oil tanker was responsible for the then largest single oil spill in USA coastal waters (NSCEP 1989), which may have been associated with the ship captain's alcohol abuse (Brown 2013). The magnitude of the environmental disaster resulting from this incident, along with other critical accidents involving drugs or alcohol in the 1980s and early 1990s, formed part of the impetus to introduce workplace drug and alcohol testing in safety-sensitive settings (Brown 2013). This introduction of testing occurred despite a dearth of empirical evidence of its effectiveness in preventing occupational accidents and injuries.

Description of the intervention

Several different approaches and interventions have been utilized to mitigate the occupational risk from alcohol or drug impairment (Dyck 2013). Interventions include voluntary peer-based assistance programs (Golan 2010), employee assistance and aftercare programs offered by the employer (Waehrer 2016), training supervisors to identify impairment (Cenovus 2011), worker education programs on substance abuse (Cook 2003), drug-free workplace policies (ACCA 2010) (with or without: drug testing (Huestis 2007), discipline (CIPD 2007), counseling (Knudsen 2004), or rehabilitation (AHRC 2012)), and unannounced random drug testing, which can be combined with other measures or used as a stand-alone intervention (VicRoads 2015).

Drug and alcohol testing can be conducted in a variety of contexts, including: pre-employment; for reasonable cause post-incident; as part of follow-up monitoring after treatment for a substance use disorder; prior to a return-to-work; or, finally, as random testing. Such testing can utilize various biological matrices to detect the presence of a specific substance or its metabolites. Cut-off levels have been established for different substances, and positive results are typically reported to the employer in a standardized fashion, consistent with the role and requirement of a licensed medical doctor (known in Canada and the USA as a Medical Review Officer) (Swotinsky 2015). However, urine drug testing, the most commonly used method, detects only the presence of metabolite(s) or parent compound(s) in a substance user, and this does not necessarily correlate to the level of impairment. Hence, the presence of a positive drug test does not necessarily confirm that the worker was impaired at the time of the work-related incident or accident. Typically, for random drug and alcohol testing (RDAT), a comprehensive screen is conducted.

The practice of RDAT varies greatly across jurisdictions. For example, in the USA, mandatory drug testing was first introduced in federally regulated workplaces in 1988 (Normand 1994). There is no federal or provincial legislation mandating drug testing of employees in Canada (Holmes 2008), and the Canadian Human Rights Commission advises that conducting testing on employees in non-safety-sensitive positions "is rarely permissible" (CHRC 2017). In Canada, it has been difficult for employers to implement RDAT in unionized environments (McLean 2015), but courts have upheld employers' right to do so when workers are in safety-sensitive positions and there is a demonstrated drug and alcohol problem in the workplace (ELPG 2017). The legal determination of whether RDAT is permissible in the workplace depends on the facts of each specific case. In unionized environments, in the absence of a legal right to conduct random testing, employers may negotiate agreements to do so. However, privacy and human rights obligations may override managerial attempts to implement RDAT.

In the European Union, there is no specific legislation nor generally accepted guidelines addressing workplace drug testing (Agius 2010). Moreover, according to Verstraete 2001, "no official co-ordinating body exists", resulting in scant statistics and difficulty obtaining information about workplace drug testing practices. Germany permits drug and alcohol testing only in exceptional circumstances for safety reasons, while Sweden only allows drug tests if employees are informed about the test well in advance (Thomson Reuters 2016). In New Zealand, employers are recommended to include drug or alcohol testing in an employment agreement after seeking legal advice; testing is more likely to infringe on privacy

and human rights legislation otherwise. In New Zealand it is not acceptable to have a policy requiring random testing for employees that do not work in safety sensitive areas, for example, even if this is included in an employment agreement (Employment New Zealand 2017). It is legal in Australia to conduct testing where it is necessary for the employer to meet safety obligations (Thomson Reuters 2016), but there is little information about workplace policies. A recent paper from Australia concluded that there was a "paucity of current nationally representative data regarding workplace AOD [alcohol or drug] policies" (Pidd 2016), with only 6.6% of participants in a national survey reporting that testing policies were present for alcohol, drugs or both at their workplace. Singapore is a notable exception among Commonweath countries, with the government itself providing workplace drug testing (Singapore 2014) and no express legal restrictions with respect to employer drug use testing (Thomson Reuters 2016). As the area of drug and alcohol testing is still young, many jurisdictions address only whether testing can be carried out at all, and legislation and policies often do not address the specifically random element of RDAT.

Despite the variability in policies, practices, and implementation, RDAT programs are generally defined by the following fundamental components: random testing is "the unscheduled, unannounced drug testing of randomly selected employees by a process designed to ensure that selections are made in a nondiscriminatory manner" (Coates 2014). Employers typically decide what percentage of employees are tested annually depending on the needs of the company. At least 50% of the workforce, tested annually, is suggested as a reasonable baseline target (Frone 2013). Testing on at least a quarterly basis is recommended by the USA Department of Transportation (US DOT 2015), which provides guidance and best practices that are widely used, including in the USA and Canada (COAA 2014).

How the intervention might work

Workplace drug testing has the primary aims of detecting and deterring drug use in workers. Research indicates that workplace drug testing is most likely to be a deterrent in more addicted or very frequent drug users (Frone 2013). Theoretically, employees who consume substances in violation of punitive workplace drug-free policies, which specify that workers will be disciplined, sanctioned, or discharged following a positive alcohol or drug test, should be motivated to discontinue consumption. A study of drug testing in the U.S. Navy, where there is a zero-tolerance policy to drug use, found RDAT to deter almost 60% of potential drug use (Borack 1998). A study of mandatory alcohol testing for large commercial truck and bus drivers found the risk of alcohol involvement in fatal crashes to drop by 23% (Brady 2009). In theory, if RDAT is found to deter employees from using alcohol or drugs, this reduction in use may, in turn, reduce the associated risk of occupational injury. Alternatively, a positive alcohol or drug test could trigger rehabilitative or positive measures, such as early entry into addiction treatment or detoxification. Non-negative or positive drug or alcohol tests in the workplace may serve as a mechanism for the early identification of workers at risk of, or affected with, an addiction or substance use disorder, who can then be referred to appropriate interventions.

It is possible that RDAT may cause workers to feel that their privacy has been invaded (Stone 1989). Rapid Site Access Programs (RSAPs) have been developed to provide third-party administration of testing, and coordination of drug and alcohol education, treatment, and counseling. The RSAP allows participants to work at any participating worksite without having to submit to a site access test for each site, thus reducing the number of tests required for individual workers (CLR 2017).

We have developed a logic model to illustrate the mechanism by which the complex intervention of RDAT programs might work (Table 1). This approach has been used in other contexts (Anderson 2011; Baxter 2010; Pigott 2013). Contextual factors comprise three main domains, including company characteristics (size, location, industry, organizational climate), job characteristics (types of positions and work content, i.e. job demands, decision latitude, effort, and schedule), and employee characteristics (especially socioeconomic status, age, sex, and tobacco smoking).

Why it is important to do this review

RDAT is a controversial subject with implications in a number of domains, including workplace health and safety as well as legal and human rights. Despite the ongoing and often vigorous debate over its benefits and limitations, the effectiveness of random workplace drug and alcohol testing as a safety strategy has received limited research attention. Although truly random unannounced testing as an intervention is claimed to have a deterrent effect on drug use, no methodologically rigorous systematic analysis of the evidence has been conducted in recent years.

It is hoped that establishing whether or not RDAT is effective at preventing workplace injury will further the development of an optimal legislative balance between privacy and human rights on the one hand and workplace safety, reduced occupational accidents, and improved worker health on the other.

OBJECTIVES

To assess the effectiveness of workplace RDAT to prevent injuries and improve noninjury outcomes in workers compared with no workplace RDAT.

METHODS

Criteria for considering studies for this review

Types of studies

Given the practical infeasibility of conducting randomized studies (especially with randomization of the individual participant) in this area, we will include randomized as well as non-randomized studies of the following types.

1. Randomized controlled trials (RCTs), defined as studies in which participants are randomly allocated into groups to receive an intervention. Identical treatment is provided to all groups with the exception of the intervention the research is designed to study (Hammond 2015).
2. Cluster-randomized trials (CRTs), which are RCTs that involve groups of participants, as opposed to individuals, as the unit of randomization. Comparisons are then made between these clusters rather than between individuals (Kaura 2015).
3. Interrupted time-series studies (ITSs), where observations of a group are taken repeatedly over time and used to establish an underlying trend, which is then interrupted by an intervention. The analysis of ITS data provides statistical evidence about whether changes in the trend represent real increases or decreases (Bernal 2017).
4. Controlled before-after studies (CBAs), in which outcomes of interest are measured in both intervention and control groups before and after an intervention has been performed (EPOC 2017a).

In order to be inclusive and capture all relevant data, we will include studies published in the peer-reviewed literature as well as considering unpublished data from clinical trial registries.

While the highest-quality (lowest risk of bias) results could be expected from RCTs, restricting the review to such trials only would result in fewer data and would neglect a substantial body of evidence that exists in the form of studies without individual participant randomization. Indeed, for RDAT, as mentioned previously, randomization of the individual participant may not be practical. Therefore, we made the decision to include other study designs such as CRTs, ITSs and CBAs, which are easier to conduct in an occupational health setting, even though they are more prone to bias. Such studies may provide important, practically relevant information on the effectiveness of RDAT. We will take the higher risk of bias inherent in these study designs into account in our analysis and conclusions.

Types of participants

We will include studies conducted in adult workers in any occupation, with the exception of commercial drivers - the subject of another Cochrane Review (Cashman 2009).

Types of interventions

We will include studies that have evaluated the effectiveness of workplace RDAT according to the following criteria.

1. Randomness: employees were selected for testing with each employee having an equal likelihood of being chosen, and with the choice made through a probabilistic method (e.g. using a random number table, a computer-generated list of random numbers, or drawing numbers out of a hat to select from a list of consecutively numbered employee names).
2. Substances tested:
   i) alcohol;
   ii) any illicit or prescription substances but no alcohol;
   iii) both alcohol and any illicit or prescription substances.
3. Frequency of testing: on at least a quarterly basis or more frequently, with scheduled retesting at regular intervals as a planned part of the program.
4. Proportion of employees tested: any, with at least 10 test results described in each contributing study.
5. Setting: any work-related setting, with the exception of those where the tested employees are commercial drivers (as this is covered in another Cochrane Review by Cashman 2009).

We will include studies that have investigated cointerventions, provided that they were implemented in both the random drug and alcohol testing and comparator arms.

Types of outcome measures

We will include studies that have evaluated the effectiveness of workplace RDAT by using any suitable measures of the following outcomes.

Primary outcomes

1. Fatal injuries. According to Ehnes 2012, an occupational injury is: "...any personal injury, disease or death resulting from an occupational accident. An occupational accident is an unexpected and unplanned occurrence, including acts of violence, arising out of or in connection with work which results in one or more workers incurring a personal injury, disease or death. An occupational injury is therefore distinct from an occupational disease, which is a disease contracted as a result of an exposure over a period of time to risk factors arising from work activity".
2. Nonfatal injuries (defined as above, but excluding incidents that result in death).
3. Noninjury accidents that according to Binch 2007 can be defined as "any unplanned event that results in damage or loss to property, plant, materials, the environment, and/or a loss of business opportunity but does not result in injury".

Secondary outcomes

1. Rate of positive results found by RDAT.
2. Absenteeism (reported as days absent per time period).
3. Adverse events associated with RDAT. We will consider any reported adverse events such as; impacts on privacy and confidentiality, including employee perceptions of intrusiveness, separately.

We will include all studies that report at least one of the above primary or secondary outcomes of interest.

Search methods for identification of studies

Electronic searches

We will conduct a systematic literature search to identify all published and unpublished studies that can be considered eligible for inclusion in this review. We have adapted the search strategy we developed for MEDLINE (Appendix 1) for use in the other electronic databases. We will arrange for the translation of key sections of potentially eligible non-English language papers, or arrange for people who are proficient in those languages to fully assess the studies for potential inclusion in the review as necessary. We will not restrict the search by date or language of publication.

We will search the following to identify potential studies.

- Cochrane Central Register of Controlled Trials (CENTRAL).
- MEDLINE (PubMed) (Appendix 1).
- PsycINFO (Appendix 2).
- Embase (Appendix 3).
- Google Scholar.
- OSH Update and OHS references collection.
- ClinicalTrials.gov (www.ClinicalTrials.gov).
- WHO International Clinical Trials Registry Platform (www.who.int/ictrp/en/).

Searching other resources

We will screen the reference lists of all primary studies and review articles for additional references and continue this in an iterative fashion until no new studies are identified. We will also search the publication history of frequently cited authors.

Data collection and analysis

Selection of studies

We will conduct the selection of eligible studies in two stages. First, two review authors (out of CE, TJ, MM) will independently screen the titles and abstracts of the systematic search results to identify studies for inclusion. Each author will assess studies as potentially eligible or ineligible. We will exclude as ineligible, studies that clearly do not fulfil our inclusion criteria, or definitely fulfil one or more exclusion criteria. At the second stage, we will retrieve the full-text publications of the potentially eligible studies and two review authors (out of CE, TJ, DK) will independently assess these and screen studies for final inclusion. We will record reasons for exclusion of the full-text studies and report them in a 'Characteristics of excluded studies' table. We will resolve any disagreement through discussion or, if required, we will consult another review author (SS). We will record the selection process in sufficient detail to complete a PRISMA study flow diagram.

Data extraction and management

We will use a data collection form for study characteristics and outcome data that will have been piloted on at least one study in the review. Two review authors (out of MM, TJ, DK) will independently extract study characteristics from the included studies. We will identify and exclude duplicates and collate multiple reports of the same study, so that each study rather than each report is the unit of interest in the review. We will extract the following study characteristics.

1. Methods: study design, total duration of study, study location, study setting, withdrawals, and date of study.
2. Participants: number, mean age or age range, race or ethnicity, sex or gender; occupation, and employer or company information.
3. Study inclusion and exclusion criteria.
4. Interventions: description of intervention, comparison, duration, intensity, content of both intervention and control conditions, and cointerventions.
5. Outcomes: description of primary and secondary outcomes specified and collected, and at which time points reported.
6. Notes: funding for study, and notable conflicts of interest of study authors.

Two review authors (out of TJ, MM, CE) will independently extract outcome data from included studies. We will note in the 'Characteristics of included studies' table if outcome data were not reported in a usable way. We will resolve disagreements by consensus or by involving another review author (SS).

After we have extracted the occupation and employer or company information from the studies, we will code the occupations into the 10 occupational structure categories of the National Occupational Classification (Statistics Canada 2017a). We will code the employer or company into the North American Industry Classification System (NAICS) branches of industry (Statistics Canada 2017b). Two review authors (of CE, DK, MM, TJ) will independently perform this coding with the agreed results from the data extraction and resolve disagreements by consensus or, where necessary, by consulting another review author (SS).

One review author (TJ) will enter data into Review Manager 5.3

(RevMan 2014). We will confirm that data are entered correctly by having a second review author (MM) spot-check study characteristics for accuracy against the study report, comparing the data presented in the systematic review with those in the study reports. Should we decide to include studies published in one or more language in which our author team is not proficient, we will arrange for a native speaker or a translator sufficiently proficient in the respective foreign language to complete a data extraction form for us.

Assessment of risk of bias in included studies

Two review authors (DK, CE) will independently assess the risk of bias in each study using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011). We will resolve any disagreements by discussion or by involving another author (SS).

We will assess the risk of bias in RCTs and CRTs according to the following standard domains, grading each potential risk of bias as high, low, or unclear in each of the domains listed.

1. Random sequence generation.
2. Allocation concealment.
3. Blinding of participants and personnel.
4. Blinding of outcome assessment.
5. Incomplete outcome data.
6. Selective outcome reporting.
7. Other biases.

For ITS studies, we will use the 'Risk of bias' criteria developed by the Cochrane EPOC group (EPOC 2017b) as follows, grading each potential risk of bias as high, low, or unclear in each of the domains listed.

1. Was the intervention independent of other changes?
2. Was the shape of the intervention effect prespecified?
3. Was the intervention unlikely to affect data collection?
4. Was knowledge of the allocated interventions adequately prevented during the study?
5. Were incomplete outcome data adequately addressed?
6. Was the study free from selective outcome reporting?
7. Was the study free from other risks of bias?

For CBA studies, we will use the 'Risk of bias' criteria as given in Sterne 2016a, grading each potential risk as low, moderate, serious, critical, or no information in each of the domains listed (Sterne 2016b).

1. Bias due to confounding.
2. Bias in selection of participants into the study.
3. Bias in classification of interventions.
4. Bias due to deviations from intended interventions.
5. Bias due to missing data.
6. Bias in measurement of outcomes.
7. Bias in selection of the reported result.

Potential confounding domains that we anticipate will be relevant to included studies are socioeconomic status, age, sex, and tobacco smoking.

For all of the 'Risk of bias' judgments, we will summarize the judgments across different studies for each of the domains listed, and will note this in a 'Risk of bias' table. We will also document evidence from study reports together with a justification for our judgments in the 'Risk of bias' table. We will judge a study to have a high risk of bias overall when a majority of domains have a high risk of bias. Conversely, we will judge a study to have a low risk of bias overall when we judge the majority of domains to have a low risk of bias.

When considering treatment effects, we will take into account the risk of bias for the studies that contribute to that outcome.

Assessment of bias in conducting the systematic review

We will conduct the review according to this published protocol and report any deviations from it in the 'Differences between protocol and review' section of the systematic review.

Measures of treatment effect

We will enter the outcome data for each study into the data tables in RevMan 2014 in order to calculate the treatment effects. We will use odds ratios, risk ratios, or risk differences, as appropriate for dichotomous outcomes, and mean differences or standardized mean differences for continuous outcomes or other types of data as reported by the authors of the studies. If effect estimates and their 95% confidence intervals or standard errors only are reported in studies, we will enter these data into RevMan using the generic inverse variance method. We will ensure that higher scores for continuous outcomes have the same meaning for the particular outcome, explain the direction to the reader, and report where the directions were reversed, if this is necessary. When the results cannot be entered in either of these ways, we will describe them in the 'Characteristics of included studies' table or enter the data into additional tables.

For ITS studies, we will extract data from the original papers and reanalyze them according to the recommended methods for analysis of ITS designs for inclusion in systematic reviews (Ramsay 2003). We will use the standardized change in level and change in slope as effect measures.

Unit of analysis issues

For studies that employ a cluster-randomized design and that report sufficient data to be included in the meta-analysis, but do not make an allowance for the design effect, we will calculate the design effect based on a fairly large assumed intracluster correlation of 0.10. We base this assumption of 0.10 being a realistic estimate by analogy with studies on implementation research (Campbell

2001). We will follow the methods stated in the *Cochrane Handbook for Systematic Reviews of Interventions* for the calculations (Higgins 2011).

Dealing with missing data

We will employ a conservative approach for dealing with missing data, preferring baseline observation carried forward over last observation carried forward, if both are reported. If it is possible to calculate values for missing data from other statistics reported in studies, we will do so. If such computation is not possible, we will contact authors to request additional data and will report which study analyses made use of unpublished data.

Assessment of heterogeneity

We will use the I^2 statistic to assess statistical heterogeneity among the trials in each meta-analysis. We will discuss any substantial statistical or clinical heterogeneity.
We will consider the following three substance groupings as being clinically heterogeneous.

1. Alcohol only.
2. Illicit or prescription substances but no alcohol.
3. Alcohol and any illicit or prescription substances.

We provide further detail about the planned assessment of clinical heterogeneity in the section Subgroup analysis and investigation of heterogeneity.

Assessment of reporting biases

If we are able to pool data from more than 10 trials in any single meta-analysis, we will create and examine a funnel plot to explore possible reporting biases.

Data synthesis

We will pool data from studies we judge to be clinically homogeneous using RevMan 2014. If more than one study provides usable data in any single comparison, we will perform a meta-analysis. We will use a random-effects model or a fixed-effect model, as appropriate, depending on the I^2 statistic.
For ITS studies, we will perform separate meta-analyses for level and slope using the generic inverse variance method.
We will narratively describe skewed data, reporting medians and interquartile ranges.
Where multiple arms are reported for a single study, we will include data from all relevant arms and will avoid double-counting by making the appropriate corrections.

'Summary of findings' table

We will create a 'Summary of findings' table using the following outcomes.

1. Fatal injuries.
2. Nonfatal injuries.
3. Noninjury accidents.
4. Rate of positive results detected by RDAT.

We will use the five GRADE considerations (study limitations, consistency of effect, imprecision, indirectness, and publication bias) to assess the quality of a body of evidence as it relates to the studies which contribute data to the meta-analyses for the prespecified outcomes. We will use the methods and recommendations described in Section 8.5 and Chapter 12 of the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011).
We will justify all decisions to down- or upgrade the quality of studies using footnotes.
We will create a GRADE table in addition to the 'Summary of findings' table, showing all of our decisions about the quality of evidence and their justifications.

Subgroup analysis and investigation of heterogeneity

We plan to conduct subgroup analyses if there are sufficient data. We will examine the effects of RDAT according to the presence or absence of four elements.

1. Safety-sensitive positions.
2. Manual labour.
3. Testing for cannabinoids.
4. Testing for opioids.

We will treat studies of different designs separately; data from the four eligible study designs will not be combined. The implications of high or low risks of bias, inherent in these study designs and specific to the studies, will be discussed.
We will analyze fatal injuries, nonfatal injuries, and noninjury accidents separately.
Further, we will pool outcome data for three comparable time points, defining short-term follow-up to be up to one month, medium-term to be between one month and one year, and long-term as more than one year.

Sensitivity analysis

We will perform a sensitivity analysis to assess the robustness of our conclusions by omitting studies with a high risk of bias.

Reaching conclusions

We will base our conclusions only on findings from the quantitative or qualitative synthesis of included studies for this review. We will avoid making recommendations for practice based on more than just the evidence, such as values and available resources. Our implications for research will suggest priorities for future research and outline the remaining uncertainties in the area.

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* *Indicates the major publication for the study*

ADDITIONAL TABLES

Table 1. Logic model

Context:
1. Company characteristics
   i) Size
   ii) Location
   iii) Industry
   iv) Organizational climate
2. Job characteristics
   i) Types of positions
   ii) Work content
3. Employee characteristics
   i) Socioeconomic status
   ii) Age
   iii) Sex or gender
   iv) Tobacco smoking
   v) Previous history of addiction or substance use disorder(s)

Inputs	Intervention	Intermediate outcomes	Longer-Term Outcomes
1. Identification of need for RDAT i) Safety-sensitive work	1. Testing i) Number of tests completed	1. Deterrence of use or nonuse related to: i) punitive action	1. Injuries i) Changes in fatal injury rate

Table 1. Logic model (*Continued*)

ii) Demonstrated drug and/or alcohol problem in the workplace iii) Desire to reduce workplace injuries and accidents 2. Resources (supplies, personnel, monetary)	ii) Number of positive test results iii) Number and percentage of employees tested iv) Schedule of testing 2. Service provision i) Employee assistance program ii) Drug and alcohol education iii) Drug and alcohol treatment 3. Data collection i) Fatal injury rate ii) Nonfatal injury rate iii) Noninjury accident rate iv) Absenteeism v) Adverse events associated with tes	(discipline, sanction, or discharge penalties); ii) rehabilitative action (receiving treatment for an addiction or substance use disorder); iii) receiving accommodations for substance use as a disability	ii) Changes in nonfatal injury rate iii) Changes in noninjury accident rate 2. Changes in rate of absenteeism 3. Adverse events associated with RD

RDAT = random drug and alcohol testing

APPENDICES

Appendix 1. MEDLINE search strategy

1	exp Alcohol Drinking/
2	exp Alcoholism/
3	exp Alcoholic Intoxication/
4	exp Ethanol/
5	or/1-4
6	exp Inhalant Abuse/
7	exp Substance Abuse, Intravenous/

(*Continued*)

8	exp Substance-Related Disorders/
9	exp Opioid-Related Disorders/
10	drug abuse.mp. or intoxication.mp.
11	or/6-10
12	exp Substance Abuse Detection/
13	exp Breath Tests/
14	exp Hematologic Tests/
15	exp Urinalysis/
16	toxicology screen*.mp.
17	random test*.mp.
18	drug test*.mp.
19	exp Mandatory Testing/
20	employment test*.mp.
21	or/12-20
22	exp Employment/
23	exp Occupations/
24	exp Workplace/
25	exp Work/
26	exp Work Performance/
27	employ*.mp.
28	work*.mp.
29	profession*.mp.
30	or/22-29
31	exp Narcotics/

(*Continued*)

32	exp Analgesics/ or exp Analgesics, Short-Acting/ or exp Analgesics, Opioid/
33	exp Codeine/
34	(demerol or pethidine).mp. or exp Meperidine/
35	dilaudid.mp. or exp Hydromorphone/ or exp Hydrocodone/ or Vicodin.mp. or tramadol.mp. or exp Tramadol/
36	exp Fentanyl/
37	exp Heroin Dependence/ or exp Heroin/
38	exp Methadone/
39	exp Mitragyna/ or kratom.mp.
40	exp Morphine/ or exp Morphine Derivatives/
41	opiate.mp. or exp Opiate Alkaloids/
42	exp Buprenorphine/ or exp Butorphanol/ or exp Tramadol/
43	exp Oxycodone/
44	exp Central Nervous System Depressants/
45	exp Barbiturates/
46	exp Benzodiazepines/
47	exp "Hypnotics and Sedatives"/
48	rohypnol.mp. or exp Flunitrazepam/
49	exp Sodium Oxybate/
50	tranquilizer.mp. or exp Tranquilizing Agents/
51	valium.mp. or exp Diazepam/
52	exp Central Nervous System Stimulants/
53	exp Amphetamines/
54	exp Cocaine/ or exp Crack Cocaine/

(*Continued*)

55	crystal meth.mp.
56	khat.mp. or exp Catha/
57	exp Methamphetamine/
58	exp Methylphenidate/
59	exp Hallucinogens/
60	exp Dextromethorphan/
61	exp Ketamine/
62	LSD.mp. or exp Lysergic Acid Diethylamide/
63	exp Mescaline/
64	exp N,N-Dimethyltryptamine/ or DMT.mp.
65	exp Phencyclidine Abuse/ or exp Phencyclidine/ or PCP.mp.
66	exp Psilocybin/
67	exp Salvia/
68	exp Street Drugs/
69	(marijuana or THC).mp. or exp Cannabis/ or exp Marijuana Abuse/ or exp Medical Marijuana/ or exp Marijuana Smoking/ or exp Dronabinol/
70	exp Psychotropic Drugs/
71	exp Designer Drugs/
72	exp 3,4-Methylenedioxyamphetamine/ or exp N-Methyl-3,4-methylenedioxyamphetamine/ or ecstasy.mp. or MDMA.mp
73	(synthetic cathinones or bath salts).mp.
74	or/31-73
75	5 or 74
76	21 and 30 and 75
77	remove duplicates from 76

Appendix 2. PsycINFO search strategy

1	exp ALCOHOLISM/
2	exp Alcohol Intoxication/
3	exp Alcohol Rehabilitation/
4	exp ETHANOL/
5	or/1-4
6	exp Drug Rehabilitation/
7	exp Drug Addiction/
8	substance abuse.mp. or exp Drug Abuse/
9	exp Drug Dependency/ or exp Drug Addiction/
10	intoxication.mp.
11	or/6-10
12	exp Drug Usage Screening/
13	exp URINALYSIS/
14	exp Employment Tests/
15	or/12-14
16	exp DRUGS/
17	exp HALLUCINOGENIC DRUGS/ or exp DESIGNER DRUGS/ or exp ANALGESIC DRUGS/ or exp NARCOTIC DRUGS/ or exp NONPRESCRIPTION DRUGS/
18	exp MORPHINE/
19	exp CODEINE/
20	exp MEPERIDINE/
21	exp TRAMADOL/
22	(hydromorphone or demerol or dilaudid or hydrocodone or vicodin).mp
23	exp FENTANYL/

(*Continued*)

24	exp HEROIN ADDICTION/ or exp HEROIN/
25	exp METHADONE/
26	(kratom or mitragyna).mp.
27	exp OPIATES/
28	exp BUPRENORPHINE/
29	butorphanol.mp.
30	exp TRAMADOL/
31	oxycodone.mp.
32	exp CNS Depressant Drugs/
33	exp BARBITURATES/
34	exp BENZODIAZEPINES/
35	exp HYPNOTIC DRUGS/
36	exp SEDATIVES/
37	rohypnol.mp. or exp Flunitrazepam/
38	exp Gamma Hydroxybutyrate/
39	exp Tranquilizing Drugs/ or exp MINOR TRANQUILIZERS/
40	valium.mp. or exp Diazepam/
41	exp CNS Stimulating Drugs/
42	exp AMPHETAMINE/
43	exp CRACK COCAINE/ or exp COCAINE/
44	exp Methamphetamine/ or crystal meth.mp.
45	(catha or khat).mp.
46	exp METHYLPHENIDATE/

(*Continued*)

47	exp N-Methyl-D-Aspartate/ or dextromethorphan.mp.
48	exp KETAMINE/
49	exp Lysergic Acid Diethylamide/ or LSD.mp.
50	exp MESCALINE/
51	DMT.mp.
52	(N,N-Dimethyltryptamine or DMT).mp.
53	exp PHENCYCLIDINE/
54	PCP.mp.
55	exp PSILOCYBIN/
56	salvia.mp.
57	street drugs.mp.
58	exp Cannabinoids/ or exp Cannabis/ or exp Tetrahydrocannabinol/ or dronabinol.mp. or exp Marijuana/
59	exp Designer Drugs/
60	mdma.mp. or exp Methylenedioxymethamphetamine/
61	or/16-60
62	5 or 11 or 61
63	62 and 15

Appendix 3. Embase search strategy

1	exp drinking behavior/ or exp alcohol consumption/
2	exp Alcoholism/ or exp alcohol intoxication/
3	exp intoxication/ or exp drug intoxication/
4	exp addiction/

(*Continued*)

5	exp drug abuse/ or exp inhalant abuse/ or exp drug abuse pattern/ or exp substance abuse/
6	or/1-5
7	exp *breath analysis/
8	exp *blood alcohol level/
9	exp *blood examination/
10	exp *urinalysis/
11	toxicology screen*.mp.
12	random test*.mp.
13	exp *drug screening/ or exp *drug testing/ or exp *testing, drug/
14	exp *mandatory testing/
15	exp *preemployment medical examination/
16	or/7-15
17	exp permanent employment/ or exp employment/ or exp parttime employment/ or exp temporary employment/ or exp full time employment/
18	exp occupation/
19	exp workplace/
20	exp work/
21	work performance.mp. or exp job performance/
22	exp employee/
23	profession*.mp.
24	or/17-23
25	exp narcotic agent/
26	exp analgesic agent/
27	exp codeine/

(*Continued*)

28	exp pethidine/
29	exp hydromorphone/
30	exp tramadol/
31	exp fentanyl/
32	heroin.mp. or exp diamorphine/
33	exp methadone/
34	exp Mitragyna/ or exp mitragynine/ or kratom.mp.
35	exp Morphine/
36	exp opiate/
37	exp buprenorphine/
38	exp oxycodone/
39	exp central depressant agent/
40	exp barbituric acid derivative/
41	exp benzodiazepine derivative/
42	exp hypnotic agent/
43	exp sedative agent/
44	exp flunitrazepam/
45	exp oxybate sodium/
46	exp tranquilizer/
47	exp diazepam/ or exp diazepam derivative/
48	exp central stimulant agent/
49	exp amphetamine derivative/
50	exp cocaine derivative/ or exp cocaine/

(*Continued*)

51	exp methamphetamine/ or exp amphetamine/
52	exp Catha edulis extract/
53	exp Methylphenidate/
54	exp psychedelic agent/
55	exp dextromethorphan/
56	exp ketamine/
57	exp lysergide/
58	exp mescaline/
59	exp n,n dimethyltryptamine/
60	exp phencyclidine abuse/ or exp phencyclidine/ or exp phencyclidine derivative/ or exp phencyclidine dependence/
61	exp psilocybine/
62	exp Salvia divinorum/ or exp Salvia/
63	exp street drug/
64	exp cannabis derivative/ or exp cannabis addiction/ or exp "cannabis use"/ or exp cannabis/ or exp cannabis smoking/ or exp medical cannabis/
65	exp anandamide/ or exp tetrahydrocannabinol/ or exp dronabinol/ or exp cannabinoid/ or exp tetrahydrocannabinolic acid/ or exp cannabidiol/
66	exp psychotropic agent/
67	exp designer drug/
68	exp 3,4 methylenedioxyamphetamine/ or exp 3,4 methylenedioxymethamphetamine/ or exp 3, 4 methylenedioxymethamphetamine/
69	exp midomafetamine/
70	exp 4' methylmethcathinone/ or bath salts.mp.
71	exp alcohol/
72	or/25-71

(*Continued*)

73	6 or 72
74	16 and 24
75	73 and 74
76	remove duplicates from 75

CONTRIBUTIONS OF AUTHORS

All authors have contributed to drafting this protocol.

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